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Original Article

# Reduced nosocomial infection rate in a neonatal intensive care unit during a 4-year surveillance period

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## Abstract

**Background:** Hospital-acquired infections are a leading cause of morbidity and mortality in neonatal intensive care units (NICU). The aim of the study was to investigate the change of nosocomial infection rate in a NICU during a 4-year surveillance period.

**Methods:** We investigated the changes in nosocomial infection rates, infection sites, and microorganism species in a NICU before and after the unit was moved to a new location, extending from November 2008 to October 2012. The new facility was opened on November 1, 2010 and the old NICU was closed on the same day. In the meantime, three catheter-based bundles were implemented in the new NICU and all intensive care units in our hospital due to the new policy. Data collection was performed by independent, experienced infection control nurses.

**Results:** A total of 512 neonates were admitted to the NICU and enrolled in this study. There were 242 infants who were admitted to the old NICU, and 270 infants in the new facility. During the study period, the rate of infection episodes decreased from 19.0% to 11.1% ( $P = 0.01$ ). Additionally, the average hospital-acquired infection rate decreased from 6.26 cases per 1000 patient-days to 4.09 cases per 1000 patient-days ( $P = 0.03$ ). The most common infection site was blood stream infection, which decreased from 8.3% to 3.7% ( $P = 0.03$ ). The total catheter-related infection rates of the blood stream, lower respiratory tract, and urinary tract decreased from 13.6% to 5.9% ( $P = 0.003$ ). *Klebsiella pneumoniae*, *E. coli*, Methicillin-resistant *Staphylococcus aureus* (MRSA), and Coagulase-negative Staphylococci (CoNS) were the most frequently found pathogens in the old NICU, whereas MRSA, CoNS, *E. faecalis*, and *A. baumannii* were the most frequently found pathogens in the new NICU.

**Conclusion:** The change in the environment and implementation of device bundles in the NICU might be associated with the nosocomial infection rate.

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**Keywords:** Cross Infection; Environment; Intensive care units; Neonatal; Patient care bundles

## 1. Introduction

Critically ill infants who receive care in a neonatal intensive care unit (NICU) are at an increased risk of nosocomial infection due to immunological immaturity and a host of invasive diagnostic and therapeutic procedures.<sup>1</sup> Prior surveillance studies have shown that the rates of nosocomial infection in NICUs range from 8.7% to 74.3%.<sup>2–6</sup> In fact, a

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rate of 17.5% was reported in a tertiary hospital in Taiwan.<sup>7</sup> In spite of the use of various infection control strategies such as prophylactic antibiotics, immunoglobulins, and physical barriers,<sup>4</sup> the prevalence of nosocomial infections in NICUs still remains high. For several decades, there has been controversy over whether or not the inanimate environment of a NICU is associated with the risk of nosocomial infection, but there have been scant few studies on this issue.<sup>6,8–11</sup> Furthermore, the Institute for Healthcare Improvement recently developed the concept of “bundles” to help health care providers more reliably deliver the best possible care for patients undergoing particular treatments with inherent risks.<sup>12–15</sup> However, limited information is available on bundle care in neonates. Herein, we compared the nosocomial infection rates and the change of microorganisms in a tertiary NICU before and after the unit was moved to a new location. Catheter care bundle strategies were introduced to the new unit.

## 2. Methods

### 2.1. Study design

This study was conducted in the tertiary-level NICU of Taichung Veterans General Hospital (TCVGH), Taiwan. The old NICU was located on the fifth floor of a ten-year-old eleven-story building. It had a total of 14 infant beds and admitted an average of 130 infants each year. Most of the neonates in the NICU were born in our delivery room, and a few of the neonates were referred from nearby obstetric clinics. A new unit located in a new facility on the same floor was constructed in the autumn of 2010. There were no differences in the total number of beds, the number of hand-washing facilities, the frequency of alcohol-based hand rubs, the number of non-contaminated trash containers, posters illustrating hand-washing instructions, and the ratio of nurses to patients (Table 1) between the two units. In the new unit, the distance between beds was decreased from 3.6 m to 3.0 m and the number of isolation rooms was reduced due to the limitation of space in the new unit (Table 1). The new facility was

opened on November 1, 2010 and the old NICU was closed on the same day. Three catheter-based bundles were implemented in the new NICU due to the new policy for all intensive care units in our hospital; the central line bundle, the ventilator bundle, and the urinary tract bundle (Table 2). The primary purpose of the bundles was to prevent central line-associated blood stream infection, ventilator-associated pneumonia, and foley-associated urinary tract infection. According to the Institute of Healthcare Improvement, the definition of a bundle is “a small, straightforward set of evidence-based practices—generally three to five—that, when performed collectively and reliably, have been proven to improve patient outcomes”.<sup>16</sup>

### 2.2. Measurements and data collection

An infection control monitoring sheet was designed to monitor every episode of nosocomial infection, infection site, and microorganism species in the study period. The sheet included such information as demographic data, use of invasive catheters, including central venous catheter, umbilical artery line, umbilical venous line, endotracheal tube and Foley, wound site, culture type, date of collection, and microorganism species. Data collection was performed by independent, experienced infection control nurses for 24 months before and after the NICU was moved to the new unit. The set of definitions proposed by the Centers for Disease Control and Prevention (CDC) in 1988 was adopted as the standard case definition.<sup>17</sup> Infections occurring after 72 h of hospital stay were assumed to be hospital-acquired; those resulting from passage through the birth canal or from transplacental

Table 2  
The elements of catheter bundles.

Items	Bundle elements
General practices	1 Staff education (a routine part of staff induction)
	2 Hand Hygiene
	3 Bundle care checklist
	4 Review catheter necessity daily and remove promptly when indications are no longer met
Central line	1 Maximal sterile barrier precautions upon insertion
	2 Antiseptic skin preparation
	3 Sterile transparent semipermeable dressing or sterile gauze
	4 Daily evaluation of catheter insertion site
	5 Maintaining closed system
	6 Aseptic technique when changing intravenous tubing
Ventilator	1 Elevate the head of the bed
	2 Mouth care with normal saline and suction of oropharyngeal secretion
	3 Daily sedation vacation for sedated infant
	4 Sterile suction and handling of respiratory equipment
	5 Drain condensation from ventilator circuit
Urinary tract	1 Sterile technique during insertion
	2 The use of securing devices to prevent the movement of the catheter after its insertion
	3 Maintaining closed system
	4 Collection bag always lower than patient especially during transport

Table 1  
Comparison of clinical setting in the old and the new Units.

Items	Old Unit	New Unit
Time of survey	2008/Nov.–2010/Oct.	2010/Nov.–2012/Oct.
Total beds	14 beds	14 beds
Ratio of nurse/patient	1/2–3	1/2–3
Distance between beds	3.6 m	3.0 m
Hand-washing facilities/beds	1/1	1/1
Figure of hand-washing steps/beds	1/1	1/1
Alcohol-based handrub/beds	1/1	1/1
Infected and non-infected trash cans/beds	One pair/1	One pair/1
Isolated rooms	2	1
Implementation device bundles care <sup>a</sup>	No	Yes

<sup>a</sup> Implementation three bundles care; central line bundle, ventilator bundle and urine tract bundle, in the new unit since Jan 1, 2011.

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